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THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE[1]

ADDRESS OF THE PRESIDENT

Thirty-one years have passed since the British Association met in Sheffield, and the interval has been marked by exceptional progress. A town has become a city, the head of its municipality a lord mayor; its area has been enlarged by more than one fifth; its population has increased from about 280,000 to 479,000. Communication has been facilitated by the construction of nearly thirty-eight miles of electric tramways for home service and of new railways, including alternative routes to Manchester and London. The supplies of electricity, gas and water have more than kept pace with the wants of the city. The first was just being attempted in 1879; the second has now twenty-three times as many consumers as in those days; the story[2] of the third has been told by one who knows it well, so that it is enough for me to say your water supply can not be surpassed for quantity and quality by any in the kingdom. Nor has Sheffield fallen behind other cities in its public buildings. In 1897 your handsome town hall was opened by the late Queen Victoria; the new post office, appropriately built and adorned with material from almost local sources, was inaugurated less than two months ago. The Mappin Art Gallery commemorates the munificence of those whose name it bears, and fosters that love of the beautiful which Ruskin sought to awaken by his gen-

[1] Sheffield, 1910.

[2] "History and Description of Sheffield Water Works," W. Terrey, 1908.

erous gifts. Last, but not least, Sheffield has shown that it could not rest satisfied till its citizens could ascend from their own doors to the highest rung of the educational ladder. Firth College, named after its generous founder, was born in the year of our last visit; in 1897 it received a charter as the University College of Sheffield, and in the spring of 1905 was created a university, shortly after which its fine new buildings were opened by the late king; and last year its library, the generous gift of Dr. Edgar Allen, was inaugurated by his successor, when Prince of Wales. I must not now dwell on the great work which awaits this and other new universities. It is for them to prove that, so far from abstract thought being antagonistic to practical work, or scientific research to the labor of the factory or foundry, the one and the other can harmoniously cooperate in the advance of knowledge and the progress of civilization.

You often permit your president on these occasions to speak of a subject in which he takes a special interest, and I prefer thus trespassing on your kindness to attempting a general review of recent progress in science. I do not, however, propose, as you might naturally expect, to discuss some branch of petrology; though for this no place could be more appropriate than Sheffield, since it was the birthplace and the lifelong home of Henry Clifton Sorby, who may truly be called the father of that science. This title he won when, a little more than sixty years ago, he began to study the structure and mineral composition of rocks by examining thin sections of them under the microscope.[3] A rare combination of a singularly versatile and active intellect with accurate thought and sound judgment, shrewd in nature, as became a Yorkshireman, yet gentle, kindly and unselfish, he was one whom his friends loved and of whom this city may well be proud. Sorby's name will be kept alive among you by the professorship of geology which he has endowed in your university; but, as the funds will not be available for some time, and as that science is so intimately connected with metallurgy, coal-mining and engineering, I venture to express hope that some of your wealthier citizens will provide for the temporary deficiency, and thus worthily commemorate one so distinguished.

But to return. I have not selected petrology as my subject, partly because I think that the great attention which its more minute details have of late received has tended to limit rather than to broaden our views, while for a survey of our present position it is enough to refer to the suggestive and comprehensive volume published last year by Mr. A. Harker;[4] partly, also, because the discussion of any branch of petrology would involve so many technicalities that I fear it would be found tedious by a large majority of my audience. So I have preferred to discuss some questions relating to the effects of ice which had engaged my attention a dozen years before I attempted the study of rock slices. As much of my petrological work has been connected with mountain districts, it has been possible for me to carry on the latter without neglecting the former, and my study of ice-work gradually led me from the highlands into the lowlands.[5] I pur-

[3] His subsequent investigations into the microscopic structure of steel and other alloys of iron, in the manufacture of which your city holds a foremost place, have been extended by Mr. J. E. Stead and others, and they, besides being of great value to industrial progress, have thrown important sidelights on more than one dark place in petrology.

[4] "The Natural History of Igneous Rocks," 1909.

[5] May I add that hereafter a statement of facts without mention of an authority means that I am speaking from personal knowledge?

pose, then, to ask your attention this evening to some aspects of the glacial history of western Europe.

At no very distant geological epoch the climate in the northern part of the earth was much colder than it is at present. So it was also in the southern; but whether the two were contemporaneous is less certain. Still more doubtful are the extent and the work of the ice which was a consequence, and the origin of certain deposits on some northern lowlands, including those of our own islands: namely, whether they are the direct leavings of glaciers or were laid down beneath the sea by floating shore-ice and bergs. Much light will be thrown on this complex problem by endeavoring to ascertain what snow and ice have done in some region which, during the glacial epoch, was never submerged, and none better can be found for this purpose than the European Alps.

At the present day one school of geologists, which of late years has rapidly increased in number, claims for glaciers a very large share in the sculpture of that chain, asserting that they have not only scooped out the marginal lakes, as Sir A. Ramsay maintained fully half a century ago, but have also quarried lofty cliffs, excavated great cirques, and deepened parts of the larger Alpine valleys by something like two thousand feet. The other school, while admitting that a glacier, under special circumstances, may hollow out a tarn or small lake and modify the features of rock scenery, declares that its action is abrasive rather than erosive, and that the sculpture of ridges, crags and valleys was mainly accomplished in pre-glacial times by running water and the ordinary atmospheric agencies.

In all controversies, as time goes on, hypotheses are apt to masquerade as facts, so that I shall endeavor this evening to disentangle the two, and call attention to those which may be safely used in drawing a conclusion.

In certain mountain regions, especially those where strong limestones, granites and other massive rocks are dominant, the valleys are often trench-like with precipitous sides, having cirques or corries at their heads, and with rather wide and gently sloping floors, which occasionally descend in steps, the distance between these increasing with that from the watershed. Glaciers have unquestionably occupied many of these valleys, but of late years they have been supposed to have taken a large share in excavating them. In order to appreciate their action we must imagine the glens to be filled up and the district restored to its former condition of a more or less undulating upland. As the mean temperature[6] declined snow would begin to accumulate in inequalities on the upper slopes. This, by melting and freezing, would soften and corrode the underlying material, which would then be removed by rain and wind, gravitation and avalanche. In course of time the hollow thus formed would assume more and more the outlines of a corrie or a cirque by eating into the hillside. With an increasing diameter it would be occupied, as the temperature fell, first by a permanent snowfield, then by the névé of a glacier. Another process now becomes important, that called "sapping." While ordinary glacier-scour tends, as we are told, to produce "sweeping curves and eventually a graded slope," "sapping" produces "benches and cliffs, its action being horizontal and backwards," and often dominant over scour. The author of this hypothesis[7] convinced himself of its truth in

[6] In the remainder of this address "temperature" is to be understood as mean temperature. The Fahrenheit scale is used.

[7] W. D. Johnson, *Science*, N. S., IX., 1899, pp. 106, 112.

the Sierra Nevada by descending a bergschrund 150 feet in depth, which opened out, as is so common, beneath the walls of a cirque. Beginning in the névé, it ultimately reached the cliff, so that for the last thirty feet the bold investigator found rock on the one hand and ice on the other. The former was traversed by fracture planes, and was in all stages of displacement and dislodgement; some blocks having fallen to the bottom, others bridging the narrow chasm, and others frozen into the névé. Clear ice had formed in the fissures of the cliff; it hung down in great stalactites; it had accumulated in stalagmitic masses on the floor. Beneath the névé the temperature would be uniform, so its action would be protective, except where it set up another kind of erosion, presently to be noticed; but in the chasm, we are informed, there would be, at any rate for a considerable part of the year, a daily alternation of freezing and thawing. Thus the cliff would be rapidly undermined and be carried back into the mountain slope, so that before long the glacier would nestle in a shelter of its own making. Farther down the valley the moving ice would become more effective than subglacial streams in deepening its bed; but since the névé-flow is almost imperceptible near the head, another agency must be invoked, that of "plucking." The ice grips, like a forceps, any loose or projecting fragment in its rocky bed, wrenches that from its place, and carries it away. The extraction of one tooth weakens the hold of its neighbors, and thus the glen is deepened by "plucking," while it is carried back by "sapping." Streams from melting snows on the slopes above the amphitheater might have been expected to coöperate vigorously in making it, but of them little account seems to be taken, and we are even told that in some cases the winds probably prevented snow from resting on the rounded surface between two cirque-heads.[8] As these receded only a narrow neck would be left between them, which would be ultimately cut down into a gap or "col." Thus a region of deep valleys with precipitous sides and heads, of sharp ridges and of more or less isolated peaks is substituted for a rather monotonous, if lofty, highland.

The hypothesis is ingenious, but some students of Alpine scenery think more proof desirable before they can accept it as an axiom. For instance, continuous observations are necessary to justify the assumption of diurnal variations of temperature sufficient to produce any sensible effect on rock at the bottom of a narrow chasm nearly fifty yards deep and almost enclosed by ice. Here the conditions would more probably resemble those in a glacière, or natural ice cave. In one of these, during the summer, curtains and festoons of ice depend from the walls; from them and from the roof water drips slowly, to be frozen into stalagmitic mounds on the floor, which is itself sometimes a thick bed of ice. On this the quantity of fallen rock débris is not greater than is usual in a cave, nor are the walls notably shattered, even though a gap some four yards deep may separate them from the ice. The floors or cirques, from which the névé has vanished, can not as a rule be examined, because they are masked by débris which is brought down by the numerous cascades, little and big, which seam their walls; but glimpses of them may sometimes be obtained in the smaller corries (which would be cirques if they could), and these show no signs of either "sapping" or "plucking," but some little abrasion by moving ice. Cirques and corries also not infre-

[8] This does not appear to have occurred in the Alps.

quently occur on the sides as well as at the heads of valleys; such, for instance, as the two in the massif of the Uri Rothstock on the way to the Surenen Pass and the Fer à Cheval above Sixt. The Lago di Ritom lies between the mouth of a hanging valley and a well-defined step, and just above that is the Lago di Cadagno in a large, steep-walled corrie, which opens laterally into the Val Piora, as that of the Lago di Tremorgio does into the southern side of the Val Bedretto. Cirques may also be found where glaciers have had a comparatively brief existence, as the Creux des Vents on the Jura; or have never been formed, as on the slopes of Salina, one of the Pipari Islands, or in the limestone desert of Lower Egypt.[9] I have seen a miniature stepped valley carved by a rainstorm on a slope of Hampstead Heath; a cirque, about a yard in height and breadth, similarly excavated in the vertical wall of a gravel pit; and a corrie, measured by feet instead of furlongs, at the foot of one of the Binns near Burntisland, or, on a much reduced scale, in a bank of earth. On all these the same agent, plunging water, has left its marks—runlets of rain for the smaller, streams for the larger; convergent at first, perhaps, by accident, afterwards inevitably combined as the hollow widened and deepened. Each of the great cirques is still a "land of streams," and they are kept permanent for the greater part of the year by beds of snow on the ledges above its walls.

The "sapping and plucking" process presents another difficulty—the steps already mentioned in the floors of valleys. These are supposed to indicate stages at which the excavating glacier transferred its operations to a higher level. But, if so, the outermost one must be the oldest, or the glacier must have been first formed in the lowest part of the incipient valley. Yet, with a falling temperature, the reverse would happen, for otherwise the snow must act as a protective mantle to the mature pre-glacial surface almost down to its base. However much age might have smoothed away youthful angularities, it would be strange if no receptacles had been left higher up to initiate the process; and even if sapping had only modified the form of an older valley, it could not have cut the steps unless it had begun its work on the lowest one. Thus, in the case of the Creux de Champ, if we hesitate to assume that the sapping process began at the mouth of the valley of the Grande Eau above Aigle, we must suppose it to have started somewhere near Ormont Dessus and to have excavated that gigantic hollow, the floor of which lies full 6,000 feet below the culminating crags of the Diablerets.

But even if "sapping and plucking" were assigned a comparatively unimportant position in the cutting out of cirques and corries, it might still be maintained that the glaciers of the ice age had greatly deepened the valleys of mountain regions. That view is adopted by Professors Penck and Brückner in their work on the glaciation of the Alps,[10] the value of which even those who can not accept some of their conclusions will thankfully admit. On one point all parties agree—that a valley cut by a fairly rapid stream in a durable rock is V-like in section. With an increase of speed the walls become more vertical; with a diminution the valley widens and has a flatter bed, over which the river, as the base-line is approached, may at last meander. Lateral streams will plough into the slopes, and may be numerous enough to convert them into alternating ridges and furrows. If a valley has been evcavated in thick horizontal beds of rock varying in

[9] A. J. Jukes-Browne, *Geol. Mag.*, 1877, p. 477.

[10] "Die Alpen in Eiszeitalter," 1909.

hardness, such as limestones and shales, its sides exhibit a succession of terrace walls and shelving banks, while a marked dip and other dominant structures produce their own modifications. It is also agreed that a valley excavated or greatly enlarged by a glacier should be U-like in section. But an Alpine valley, especially as we approach its head, very commonly takes the following form. For some hundreds of feet up from the torrent it is a distinct V; above this the slopes become less rapid, changing, say, from 45° to not more than 30°, and that rather suddenly. Still higher comes a region of stone-strewn upland valleys and rugged crags, terminating in ridges and peaks of splintered rock, projecting from a mantle of ice and snow. The V-like part is often from 800 to 1,000 feet in depth, and the above-named authors maintain that this, with perhaps as much of the more open trough above, was excavated during the glacial epoch. Thus the floor of any one of these valleys prior to the ice age must often have been at least 1,800 feet above its present level.[11] As a rough estimate we may fix the deepening of one of the larger pennine valleys, tributary to the Rhone, to have been, during the ice age, at least 1,600 feet in their lower parts. Most of them are now hanging valleys; the stream issuing, on the level of the main river, from a deep gorge. Their tributaries are rather variable in form; the larger as a rule being more or less V-shaped; the shorter, and especially the smaller, corresponding more with the upper part of the larger valleys; but their lips generally are less deeply notched. Whatever may have been the cause, this rapid change in slope must indicate a corresponding change of action in the erosive agent. Here and there the apex of the V may be slightly flattened, but any approach to a real U is extremely rare. The retention of the more open form in many small, elevated recesses, from which at the present day but little water descends, suggests that where one of them soon became buried under snow,[12] but was insignificant as a feeder of a glacier, erosion has been for ages almost at a standstill.

The V-like lower portion in the section of one of the principal valleys, which is all that some other observers have claimed for the work of a glacier, can not be ascribed to subsequent modification by water, because ice-worn rock can be seen in many places, not only high up its sides, but also down to within a yard or two of the present torrent.

Thus valley after valley in the Alps seems to leave no escape from the following dilemma: Either a valley cut by a glacier does not differ in form from one made by running water, or one which has been excavated by the latter, if subsequently occupied, is but superficially modified by ice. This, as we can repeatedly see in the higher Alpine valleys, has not succeeded in obliterating the physical features due to the ordinary processes of erosion. Even where its effects are most striking, as in the Spitallamm below the Grimsel Hospice, it has not wholly effaced those features; and wherever a glacier in a recent retreat has exposed a rock surface, that demonstrates its inefficiency as a plough. The evidence of such cases has been pronounced inadmissible, on the ground that

[11] The amount varies in different valleys; for instance, it was fully 2,880 feet at Amsteg on the Reuss, just over 2,000 feet at Brieg in the Rhone Valley, about 1,000 feet at Guttanen in the Aare Valley, about 1,550 feet above Zermatt and 1,100 feet above Saas Grund.

[12] My own studies of mountain districts have led me to infer that on slopes of low grade the action of snow is preservative rather than destructive. That conclusion was confirmed by Professor Garwood in a communication to the Royal Geographical Society on June 20 of the present year.

the glaciers of the Alps have now degenerated into senile impotence; but in valley beds over which they passed when in the full tide of their strength the flanks show remnants of rocky ridges only partly smoothed away, and rough rock exists on the "lee-sides" of ice-worn mounds which no imaginary plucking can explain. The ice seems to have flowed over rather than to have plunged into the obstacles in its path, and even the huge steps of limestone exposed by the last retreat of the Unter Grindelwald Glacier have suffered little more than a rounding off of their angles, though that glacier must have passed over them when in fullest development, for it seems impossible to explain these by any process of sapping.

The comparatively level trough, which so often forms the uppermost part of one of the great passes across the watershed of the Alps, can hardly be explained without admitting that in each case the original watershed has been destroyed by the more rapid recession of the head of the southern valley, and this work bears every sign of having been accomplished in pre-glacial times. Sapping and plucking must have operated on a gigantic scale to separate the Viso from the Cottian watershed, to isolate the huge pyramid of the Matterhorn, with its western spur, or to make, by the recession of the Val Macugnaga, that great gap between the Strahlhorn and Monte Rosa. Some sceptics even go so far as to doubt whether the dominant forms of a non-glaciated region differ very materially from those of one which has been half-buried in snowfields and glaciers. To my eyes, the general outlines of the mountains about the Lake of Gennesaret and the northern part of the Dead Sea recalled those around the Lake of Annecy and on the southeastern shore of Leman. The sandstone crags, which rise here and there like ruined castles from the lower plateau of the Saxon Switzerland, resembled in outlines, though on a smaller scale, some of the dolomites in the southern Tyrol. The Lofoten Islands illustrate a half-drowned mountain range from which the glaciers have disappeared. Those were born among splintered peaks and ridges, which, though less lofty, rival in form the Aiguilles of Chamonix, and the valleys become more and more iceworn as they descend, till the coast is fringed with skerries every one of which is a roche moutonnée. The névé in each of these valleys has been comparatively ineffective; the ice has gathered strength with the growth of the glacier. As can be seen from photographs, the scenery of the heart of the Caucasus or of the Himalayas differs in scale rather than in kind from that of the Alps. Thus the amount of abrasion varies, other things being equal, with the latitude. The grinding away of ridges and spurs, the smoothing of the walls of troughs,[13] is greater in Norway than in the Alps; it is still greater in Greenland than in Norway, and it is greatest of all in the Antarctic, according to the reports of the expeditions led by Scott and Shackleton. But even in Polar regions, under the most favorable conditions, the dominant outlines of the mountains, as shown in the numerous photographs taken by both parties, and in Dr. Wilson's admirable drawings, differ in degree rather than in kind from those of mid-European ranges. It has been asserted that the parallel sides of the larger Alpine valleys—such as the Rhone above Martigny, the Lütschine near Lauterbrunnen, and the Val Bedretto below Airolo—prove that they have been made by the ice-plough rather than by running water; but in the

[13] If one may judge from photographs, the smoothing of the flanks of a valley is unusually conspicuous in Milton Sound, New Zealand.

first I am unable to discern more than the normal effects of a rather rapid river which has followed a trough of compartively soft rocks; in the second, only the cliffs marking the channel cut by a similar stream through massive limestones—cliffs like those which elsewhere rise up the mountain flanks far above the levels reached by glaciers; while in the third I have failed to discover, after repeated examination, anything abnormal.

Many lake basins have been ascribed to the erosive action of glaciers. Since the late Sir A. Ramsay advanced this hypothesis numbers of lakes in various countries have been carefully investigated and the results published, the most recent of which is the splendid work on the Scottish lochs by Sir J. Murray and Mr. L. Pullar.[14] A contribution to science of the highest value, it has also a deeply pathetic interest, for it is a father's memorial to a much-loved son, F. P. Pullar, who, after taking a most active part in beginning the investigation, lost his life while saving others from drowning. As the time at my command is limited, and many are acquainted with the literature of the subject, I may be excused from saying more than that even these latest researches have not driven me from the position which I have maintained from the first—namely, that while many tarns in corries and lakelets in other favorable situations are probably due to excavation by ice, as in the mountainous districts of Britain, in Scandinavia, or in the higher parts of the Alps, the difficulty of invoking this agency increases with the size of the basin—as, for example, in the case of Loch Maree or the Lake of Annecy—till it becomes insuperable. Even if Glas Llyn and Llyn Llydaw were the work of a glacier, the rock basins of Gennesaret and the Dead Sea, still more those of the great lakes in North America and in Central Africa, must be assigned to other causes.

I pass on, therefore, to mention another difficulty in this hypothesis—that the Alpine valleys were greatly deepened during the glacial epoch—which has not yet, I think, received sufficient attention. From three to four hundred thousand years have elapsed, according to Penck and Brückner, since the first great advance of the Alpine ice. One of the latest estimates of the thickness of the several geological formations assigns 4,000 feet[15] to the Pleistocene and Recent, 13,000 to the Pliocene, and 14,000 to the Miocene. If we assume the times of deposit to be proportional to the thicknesses, and adopt the larger figure for the first-named period, the duration of the Pliocene would be 1,300,000 years, and of the Miocene 1,400,000 years. To estimate the total vertical thickness of rock which has been removed from the Alps by denudation is far from easy, but I think 14,000 feet would be a liberal allowance, of which about one seventh is assigned to the ice age. But during that age, according to a curve given by Penck and Brückner, the temperature was below its present amount for rather less than half (.47) the time. Hence it follows that, since the sculpture of the Alps must have begun at least as far back as the Miocene period, one seventh of the work has been done by ice in not quite one fifteenth of the time, or its action must be very potent. Such data as are at our command make it probable that a Norway glacier at the present day lowers its basin by only about eighty millimeters in 1,000 years; a Greenland glacier may remove some 421 millimeters in the same time, while the Vatnajökul in Iceland attains to 647 millimeters. If Alpine glaciers had

[14] "Bathymetrical Survey of the Scottish Freshwater Lochs," Sir J. Murray and Mr. L. Pullar, 1910.

[15] I have doubts whether this is not too great.

been as effective as the last-named, they would not have removed, during their 188,000 years of occupation of the Alpine valleys, more than 121.6 meters, or just over 397 feet; and as this is not half the amount demanded by the more moderate advocates of erosion, we must either ascribe an abnormal activity to the vanished Alpine glaciers, or admit that water was much more effective as an excavator.

We must not forget that glaciers can not have been important agents in the sculpture of the Alps during more than part of Pleistocene times. That sculpture probably began in the Oligocene period; for rather early in the next one the great masses of conglomerate, called Nagelfluh, show that powerful rivers had already carved for themselves valleys corresponding generally with and nearly as deep as those still in existence. Temperature during much of the Miocene period was not less than 12° F. above its present average. This would place the snow-line at about 12,000 feet.[16] In that case, if we assume the altitudes unchanged, not a snowfield would be left between the Simplon and the Maloja, the glaciers of the Pennines would shrivel into insignificance, Monte Rosa would exchange its drapery of ice for little more than a tippet of frozen snow. As the temperature fell the white robes would steal down the mountain-sides, the glaciers grow, the torrents be swollen during all the warmer months, and the work of sculpture increase in activity. Yet with a temperature even 6° higher than it now is, as it might well be at the beginning of the Pliocene period, the snow-line would be at 10,000 feet; numbers of glaciers would have disappeared, and those around the Jungfrau and the Finster Aarhorn would be hardly more important than they now are in the western Oberland.

But denudation would begin so soon as the ground rose above the sea. Water, which can not run off the sand exposed by the retreating tide without carving a miniature system of valleys, would never leave the nascent range intact. The Miocene Alps, even before a patch of snow could remain through the summer months, would be carved into glens and valleys. Towards the end of that period the Alps were affected by a new set of movements, which produced their most marked effects in the northern zone from the Inn to the Durance. The Oberland rose to greater importance; Mont Blanc attained its primacy; the massif of Dauphiné was probably developed. That, and still more the falling temperature, would increase the snowfields, glaciers and torrents. The first would be, in the main, protective; the second, locally abrasive; the third, for the greater part of their course, erosive. No sooner had the drainage system been developed on both sides of the Alps than the valleys on the Italian side (unless we assume a very different distribution of rainfall) would work backwards more rapidly than those on the northern. Cases of trespass, such as that recorded by the long level trough on the north side of the Maloja Kulm and the precipitous descent on the southern, would become frequent. In the interglacial episodes—three in number, according to Penck and Brückner, and occupying rather more than half the epoch—the snow and ice would dwindle to something like its present amount, so that the water would resume its work. Thus I think it far more probable that the V-like por-

[16] I take the fall of temperature for a rise in altitude as 1° F. for 300 feet or, when the differences in the latter are large, 3° per 1,000 feet. These estimates will, I think, be sufficiently accurate. The figures given by Hann (see for a discussion of the question, *Report of Brit. Assoc.*, 1909, p. 93) work out to 1° F. for each 318 feet of ascent (up to about 10,000 feet).

tions of the Alpine valleys were in the main excavated during Pliocene ages, their upper and more open parts being largely the results of Miocene and yet earlier sculpture.)

During the great advances of the ice, four in number, according to Penck and Brückner,[17] when the Rhone glacier covered the lowlands of Vaud and Geneva, welling on one occasion over the gaps in the Jura, and leaving its erratics in the neighborhood of Lyons, it ought to have given signs of its erosive no less than of its transporting power. But what are the facts? In these lowlands we can see where the ice has passed over the Molasse (a Miocene sandstone); but here, instead of having crushed, torn and uprooted the comparatively soft rock, it has produced hardly any effect. The huge glacier from the Linth Valley crept for not a few miles over a floor of stratified gravels, on which, some eight miles below Zurich, one of its moraines, formed during the last retreat, can be seen resting, without having produced more than a slight superficial disturbance. (We are asked to credit glaciers with the erosion of deep valleys and the excavation of great lakes, and yet, wherever we pass from the hypotheses to facts, we find them to have been singularly inefficient workmen!)

I have dwelt at considerable, some may think undue, length on the Alps, because we are sure that this region from before the close of the Miocene period has been above the sea-level. It accordingly demonstrates what effects ice can produce when working on land.

In America also, to which I must now make only a passing reference, great ice-sheets formerly existed: one occupying the district west of the Rocky Mountains, another spreading from that on the northwest of Hudson's Bay, and a third from the Laurentian hill-country. These two became confluent, and their united ice-flow covered the region of the Great Lakes, halting near the eastern coast a little south of New York, but in Ohio, Indiana and Illinois occasionally leaving moraines only a little north of the 39th parallel of latitude.[18] Of these relics my first-hand knowledge is very small, but the admirably illustrated reports and other writings of American geologists[19] indicate that, if we make due allowance for the differences in environment, the tills and associated deposits on their continent are similar in character to those of the Alps.[20]

In our own country and in corresponding parts of northern Europe we must take into account the possible cooperation of the sea. In these, however, geologists agree that, for at least a portion of the ice age, glaciers occupied the mountain districts. Here ice-worn rocks, moraines and perched blocks, tarns in corries, and perhaps lakelets in valleys, demonstrate the former presence of a mantle of snow and ice. Glaciers radiated outwards from more than one focus in Ireland, Scotland, the English Lake District, and Wales, and trespassed, at the time of their greatest development, upon the adjacent lowlands. They are generally believed to have advanced and retreated more than once, and

[17] On the exact number I have not had the opportunity of forming an opinion.

[18] Some of the glacial drifts on the eastern side of the continent, as we shall find, may have been deposited in the sea.

[19] See the Reports of the United States Geological Survey (from Vol. III. onwards), *Journal of Geology, American Journal of Science*, and local publications too numerous to mention. Among these the studies in Greenland by Professor Chamberlin are especially valuable for the light they throw on the movement of large glaciers and the transport of débris in the lower part of the ice.

[20] Here, however, we can not always be so sure of the absence of the sea.

their movements have been correlated by Professor J. Geikie with those already mentioned in the Alps. Into that very difficult question I must not enter; for my present purpose it is enough to say that in early Pleistocene times glaciers undoubtedly existed in the mountain districts of Britain and even formed piedmont ice-sheets on the lowlands. On the west side of England, smoothed and striated rocks have been observed near Liverpool, which can hardly be due to the movements of shore-ice, and at Little Crosby a considerable surface has been cleared from the overlying boulder clay by the exertions of the late Mr. T. M. Reade and his son, Mr. A. Lyell Reade. But, so far as I am aware, rocks thus affected have not yet been discovered in the Wirral peninsula. On the eastern side of England similar markings have been found down to the coast of Durham, but a more southern extension of land ice can not be taken for granted. In this direction, however, so far as the tidal valley of the Thames, and in corresponding parts of the central and western lowlands, certain deposits occur which, though to a great extent of glacial origin, are in many respects different from those left by land ice in the Alpine regions and in northern America.

They present us with problems the nature of which may be inferred from a brief statement of facts. On the Norfolk coast we find the glacial drifts resting, sometimes on the chalk, sometimes on strata of very late Pliocene or early Pleistocene age. The latter show that in their time the strand-line must have oscillated slightly on either side of its present level. The earliest of the glacial deposits, called the Cromer Till and Contorted Drift, presents its most remarkable development in the cliffs on either side of that town. Here it consists of boulder clays and alternating beds of sand and clay; the first-named, two or three in number, somewhat limited in extent, and rather lenticular in form, are slightly sandy clays, full of pieces of chalk, flint and other kinds of rock, some of the last having traveled from long distances. Yet more remarkable are the huge erratics of chalk, in the neighborhood of which the sands and clays exhibit extraordinary contortions. Like the beds of till, they have not been found very far inland, for there the group appears as a whole to be represented by a stony loam, resembling a mixture of the sandy and clayey material, and this is restricted to a zone some twenty miles wide, bordering the coast of Norfolk and Suffolk; not extending south of the latter country, but being probably represented to the north of the Humber. Above these a group of false-bedded sands and gravels, variable in thickness and character—the Mid-glacial Sands of Searles V. Wood and F. W. Harmer. They extend over a wider area, and may be traced, according to some geologists, nearly to the western side of England, rising in that direction to a greater height above sea-level. But as it is impossible to prove that all isolated patches of these materials are identical in age, we can only be certain that some of them are older than the next deposit, a boulder clay, which extends over a large part of the lowlands in the eastern counties. This has a general resemblance to the Cromer Till, but its matrix is rather more clayey and is variable in color. In the north of Yorkshire, as well as on the seaward side of the Lincolnshire wolds, it is generally brownish or purplish, but on their western side and as far as the clay goes to the south it is some shade of gray. Near to these wolds, in mid-Norfolk, and on the northern margin of Suffolk, it has a whitish tint, owing to the abundance of comminuted chalk.

To the south and west of this area it is dark, from the similar presence of Kimeridge clay. Yet further west it assumes an intermediate color by having drawn upon the Oxford clay. This boulder clay, whether the chalky or the purple, in which partings of sand sometimes occur, must once have covered, according to Mr. F. W. Harmer, an area about ten thousand square miles in extent. It spreads like a covelet over the pre-glacial irregularities of the surface. It caps the hills, attaining sometimes an elevation of fully 500 feet above sea-level;[21] it fills up valleys,[22] sometimes partly, sometimes wholly, the original floors of which occasionally lie more than 100 feet below the same level. This boulder clay, often with an underlying sand or gravel, extends to the south as far as the neighborhood of Muswell Hill and Finchley; hence its margin runs westward through Buckinghamshire, and then, bending northwards, passes to the west of Coventry. On this side of the Pennine Chain the matrix of the boulder clay is again reddish, being mainly derived from the sands and marls of the Trias; pieces of chalk and flint are rare (no doubt coming from Antrim), though other rocks are often plentiful enough. Some authorities are of the opinion that the drift in most parts of Lancashire and Cheshire is separable, as on the eastern coasts, into a lower and an upper boulder clay, with intervening gravelly sands, but others think that the association of the first and third is lenticular rather than successive. Here also the lower clay can not be traced very far inland, eastward or southward; the others have a wider extension, but they reach a greater elevation above sea-level than on the eastern side of England. The sand is inconstant in thickness, being sometimes hardly represented, sometimes as much as 200 feet. The upper clay runs on its more eastern side up to the chalky boulder clay, and extends on the south at least into Worcestershire. On the western side it merges with the upper member of the drifts radiating from the mountains of North Wales, which often exhibit a similar tripartite division, while (as we learn from the officers of the Geological Survey) boulder clays and gravelly sands, which it must suffice to mention, extend from the highlands of South Wales for a considerable distance to the southeast and south. Boulder clay has not been recognized in Devon or Cornwall, though occasional erratics are found which seem to demand some form of ice-transport. A limited deposit, however, of that clay, containing boulders now and then over a yard in diameter, occurs near Selsey Bill on the Sussex coast, which most geologists consider to have been formed by floating rather than by land ice.

Marine shells are not very infrequent in the lower clays of East Anglia and Yorkshire, but are commonly broken. The well-known Bridlington Crag is the most conspicuous instance, but this is explained by many geologists as an erratic—a piece of an ancient North Sea bed caught up and transported, like the other molluscs, by an

[21] Not far from Royston it is found at a height of 525 feet above O.D. See F. W. Harmer, "Pleistocene Period in the Eastern Counties," p. 115.

[22] At Old North Road Station, on a tributary of the Cam, the boulder clay was pierced to a depth of 180 feet, and at Impington it goes to 60 feet below sea-level. Near Hitchin, a hidden valley, traced for seven or eight miles, was proved to a depth of 68 feet below O.D., and one near Newport in Essex, to 140 feet. Depths were also found of 120 feet at West Horseheath in Suffolk, of 120 feet on low ground two miles southwest of Sandy in Bedfordshire, of from 100 to 160 feet below the sea at Fossdyke, Long Sutton and Boston, and at Glemsford in the valley of the Stour 477 feet of drift was passed through before reaching the chalk. See F. W. Harmer, *Quart. Journ. Geol. Soc.*, LXIII., 1907, p. 494.

advancing ice-sheet. They also claim a derivative origin for the organic contents of the overlying sands and gravels, but some authorities consider the majority to be contemporaneous. Near the western coast of England, shells in much the same state of preservation as those on the present shores are far from rare in the lower clay, where they are associated with numerous striated stones, often closely resembling those which have traveled beneath a glacier, both from the Lake District and the less distant Trias. Shells are also found in the overlying sands up the valleys of the Dee and Severn, at occasional localities, even as far inland as Bridgnorth, the heights of the deposits varying from about 120 feet to over 500 feet above the sea-level. If we also take account of the upper boulder clay, where it can be distinguished, the list of marine molluscs, ostracods and foraminifers from these western drifts is a rather long one.[23]

Marine shells, however, on the western side of England, are not restricted to the lowlands. Three instances, all occurring over 1,000 feet above sea-level, claim more than a passing mention. At Macclesfield, almost thirty miles in a straight line from the head of the estuary of the Mersey, boulder clays associated with stratified gravels and sands have been described by several observers.[24] The clay stops at about 1,000 feet, but the sands and gravels go on to nearly 1,300 feet, while isolated erratics are found up to about 100 feet higher. Sea shells, some of which are in good condition, have been obtained at various elevations, the highest being about 1,200 feet above sea-level. About forty-eight species of molluscs have been recognized, and the fauna, with a few exceptions, more arctic in character and now found at a greater depth, is one which at the present day lives in a temperate climate at a depth of a few fathoms.

The shell-bearing gravels at Gloppa, near Oswestry, which are about thirty miles from the head of the Dee estuary, were carefully described in 1892 by Mr. A. C. Nicholson. He has enumerated fully sixty species, of which, however, many are rare. As his collection[25] shows, the bivalves are generally broken, but a fair number of the univalves are tolerably perfect. The deposit itself consists of alternating seams of sand and gravel, the one generally about an inch in thickness, the other varying from a few inches to a foot. The difference in the amount of rounding shown by the stones is a noteworthy feature. They are not seldom striated; some have come from Scotland, others from the Lake District, but the majority from Wales, the last being the more angular. Here and there, a block, sometimes exceeding a foot in diameter and usually from the last-named country, has been dropped among the smaller material, most of which ranges in diameter from half an inch to an inch and a half. The beds in one or two places show contortions; but as a rule, though slightly wavy and with a gentle dip rather to the west of south, they are uniformly deposited. In this respect, and in the unequal wearing of the materials, the Gloppa deposit differs from most gravels that I have seen. Its situation also is peculiar. It is on the flattened top of a rocky spur from higher hills, which falls rather steeply to the Shropshire low-

[23] W. Shone, *Quart. Journ. Geol. Soc.*, XXXIV., 1878, p. 383.

[24] *Memoirs of the Geological Survey:* "Country around Macclesfield," T. I. Pocock, 1906, p. 85. For some notes on Moel Tryfaen and the altitudes of other localities at which marine organisms have been found see J. Gwyn Jeffreys, *Quart. Journ. Geol. Soc.*, XXXVI., 1880, p. 351. For the occurrence of such remains in the Vale of Clwyd see a paper by T. McK. Hughes in *Proc. Chester Soc. of Nat. Hist.*, 1884.

[25] Now deposited in the Oswestry Museum.

land on the eastern side, and on the more western is defined by a small valley which enlarges gradually as it descends towards the Severn. If the country were gradually depressed for nearly 1,200 feet, this upland would become, first a promontory, then an island, and finally a shoal.

The third instance, on Moel Tryfaen in Carnarvonshire, was carefully investigated and described by a committee of this association[26] about ten years ago. The shells occur in an irregularly stratified sand and gravel, resting on slate, and overlain by a boulder clay, no great distance from and a few dozen feet below the rocky summit of the hill, being about 1,300 feet above the level of the sea and at least five miles from its margin. About fifty-five species of molluses and twenty-three of foraminifers have been identified. According to the late Dr. J. Gwyn Jeffreys,[27] the majority of the molluses are littoral in habit, the rest such as live in from ten to twenty fathoms of water. Most of the erratics have been derived from the Welsh mountains, but some rocks from Anglesey have also been obtained, and a few pebbles of Lake District and Scotch rocks. If the sea were about 1,300 feet above its present level, Moel Tryfaen would become a small rocky island, open to the storms from the west and north, and nearly a mile and a half away from the nearest land.

I must pass more rapidly over Ireland. The signs of vanished glaciers—ice-worn rocks and characteristic boulder-clays—are numerous, and may be traced in places down to the sea-level, but the principal outflow of the ice, according to some competent observers, was from a comparatively low district, extending diagonally across the island from the south of Lough Neagh to north of Galway Bay. Glaciers, however, must have first begun to form in the mountains on the northern and southern side of this zone, and we should have expected that, whatever might happen on the lowlands, they would continue to assert themselves. In no other part of the British Islands are eskers, which some geologists think were formed when a glacier reached the sea, so strikingly developed. Here also an upper and a lower boulder clay, the former being the more sparsely distributed, are often divided by a widespread group of sands and gravels, which locally, as in Great Britain, contains, sometimes abundantly, shells and other marine organisms; more than twenty species of molluscs, with foraminifers, a barnacle, and perforations of annelids, having been described. These are found in counties Dublin and Wicklow, at various altitudes,[28] from a little above sea-level to a height of 1,300 feet.

Not the least perplexing of the glacial phenomena in the British Isles is the distribution of erratics, which has been already mentioned in passing. On the Norfolk coast, masses of chalk, often thousands of cubic feet in volume, occur in the lowest member of the glacial series, with occasional great blocks of sand and gravel, which must have once been frozen. But these, or at any rate the larger of them, have no doubt been derived from the immediate neighborhood. Huge erratics also occasionally occur in the upper boulder clay—sometimes of chalk, as at Roslyn Hill near Ely and at Ridlington in Rutland, of jurassic limestone, near Great Ponton, to the south of Grantham, and of Lower Kimeridge clay near Biggleswade.[29] These

[26] *Brit. Assoc. Report*, 1899 (1900), pp. 414–423.

[27] *Quart. Journ. Geol. Soc.*, XXXVI., 1880, p. 355.

[28] See T. M. Reade, *Proc. Liverpool Geol. Soc.*, 1893–94, p. 183, for some weighty arguments in favor of a marine origin for these deposits.

[29] H. Home, *Quart. Journ. Geol. Soc.*, LIX., 1903, p. 375.

also probably have not traveled more than a few miles. But others of smaller size have often made much longer journeys. The boulder clays of eastern England are full of pieces of rock, commonly ranging from about half an inch to a foot in diameter. Among these are samples of the carboniferous, jurassic and cretaceous rocks of Yorkshire and the adjacent counties; the red chalk from either Hunstanton, Speeton or some part of the Lincolnshire wolds, being found as far south as the northern heights of London. Even the chalk and flint, the former of which, especially in the upper boulder clay, commonly occurs in well-worn pebbles, are frequently not the local but the northern varieties. And with these are mingled specimens from yet more distant sources—Cheviot porphyrites, South Scotch basalts, even some of the crystalline rocks of the Highlands. Whatever was the transporting agent, its general direction was southerly, with a slight deflection towards the east in the last-named cases.

But the path of these erratics has been crossed by two streams, one coming from the west, the other from the east. On the western side of the Pennine watershed the Shap granite rises at Wasdale Crag to a height of about 1,600 feet above sea-level. Boulders from it have descended the Eden valley to beyond Penrith; they have traveled in the opposite direction almost to Lancaster,[30] and a large number of them have actually made their way near the line of the Lake District watershed, across the upper valley of the Eden, and over the high pass of Stainmoor Forest,[31] whence they descended into Upper Teesdale. Subsequently the stream seems to have bifurcated, one part passing straight out to the present sea-bed, by way of the lower course of the Tees, to be afterwards driven back on to the Yorkshire coast. The other part crossed the low watershed between the Tees and the Ouse, descended the Vale of York and spread widely over the plain.[32] Shap boulders by some means penetrated into the valleys tributary to the Ause on its west bank, and they have been observed as far to the southeast as Royston, near Barnsley. It is noteworthy that Lake District rocks have been occasionally recorded from Airedale and even the neighborhood of Colne, though the granite from Shap has not been found there. The other stream started from Scandinavia. Erratics, some of which must have come from the northwestern side of the Christiania Fjord, occur on or near the coast from Essex to Yorkshire, and occasionally even as far north as Aberdeen, while they have been traced from the East Anglian coast to near Ware, Hitchin and Bedford.[33] It may be important to notice that these Scandinavian erratics are often waterworn, like those dispersed over Denmark and parts of northern Germany.

On the western side of England the course of erratics is not less remarkable. Boulders from southwestern Scotland, especially from the Kirkcudbright district, both waterworn and angular, are scattered over the lowlands as far south as Wolverhampton, Bridgnorth and Church Stretton. They may be traced along the border of North Wales, occurring, as has been said, though generally small, up to about 1,300 feet on Moel Tryfaen, 1,100 feet at Gloppa,

[30] A pebble of it is said to have been identified at Moel Tryfaen.

[31] The lowest part of the gap is about 1,400 feet. A little to the south is another gap about 200 feet lower, but none of the boulders seem to have taken that route.

[32] A boulder was even found above Grosmont in the Eske valley, 345 feet above sea-level.

[33] R. H. Rastall and J. Romanes, *Quart. Journ. Geol. Soc.*, LXV., 1909, p. 246.

and more than that height on the hills east of Macclesfield. Boulders from the Lake District are scattered over much the same area and attain the same elevation, but extend, as might be expected, rather farther to the east in Lancashire. They also have been found on the eastern side of the Pennine watershed, perhaps the most remarkable instances being in the dales of the Derbyshire Derwent and on the adjacent hills as much as 1,400 feet above the sea-level.[34] A third remarkable stream of erratics from the neighborhood of the Arenig Mountains extends from near the estuary of the Dee right across the paths of the two streams from the north, its eastern border passing near Rugeley, Birmingham and Bromsgrove. They also range high, occurring almost 900 feet above sea-level on Romsley Hill, north of the Clents, and being common at Gloppa. Boulders also from the basalt mass of Rowley Regis have traveled in some cases between four and five miles, and in directions ranging from rather west of south to northeast; and, though that mass hardly rises above the 700-feet contour line, one lies with an Arenig boulder on Romsley Hill. From Charnwood Forest, the crags of which range up to about 850 feet above sea-level, boulders have started which have been traced over an area to the south and west to a distance of more than twenty miles.

T. G. Bonney

(*To be concluded*)

[34] Communication from Dr. H. Arnold-Bemrose.

THE AMERICAN FISHERIES SOCIETY

The American Fisheries Society will hold its Fortieth Anniversary Meeting in New York City, September 27 to 29, 1910.

On Tuesday, the 27th, the society will meet at the New York Aquarium, in Battery Park, at 10 A.M. The members will be welcomed by Director Townsend, with an address on "The Conservation of Our Rivers and Lakes." The regular reading and discussion of papers will follow. A luncheon will be provided at the Aquarium by the New York Zoological Society. The afternoon session will begin at 2 P.M.

On Wednesday, the 28th, the meeting will be held at the American Museum of Natural History, 77th Street and Central Park, West. The morning session will begin at 10 o'clock; the afternoon session at 2.30. A luncheon will be provided by the trustees of the museum. All papers requiring the use of the stereopticon will be presented on Wednesday, in order that advantage may be taken of the excellent facilities afforded by the Museum.

On Thursday, the 29th, meetings will again be held at the aquarium at 10 A.M. and at 2 P.M.

The Hotel Navarre, at 38th Street and 7th Avenue, has been selected as the headquarters of the society, and special rates have been secured. It is centrally located in a district containing most of the theaters and many of the larger hotels and restaurants. It is four blocks from the Subway, five blocks from the Sixth and Ninth Avenue elevated stations, eight blocks from the Grand Central Station and six blocks from the new Pennsylvania Station. Accommodations should be reserved in advance, if possible.

No special entertainments have been arranged for the meeting in New York, the committee being of the opinion that the visiting members will prefer the amusements afforded by the city.

The Fishmongers Association extends a cordial invitation to the members of the society to visit the Fulton Fish Market, Pier 17, East River, foot of Fulton Street. The market should be visited in the morning—the earlier the better.

Correspondence intended for the officers or members of the society should be sent in care of the New York Aquarium, Battery Park.

Members expecting to be present are urgently requested to so inform the chairman, in order that complete arrangements may be made.

CONTRIBUTORS AND TITLES OF PAPERS TO BE READ

John P. Babcock, Deputy Fish Commissioner of British Columbia, Victoria, B. C.: "Some Experiments in the Burial of Salmon Eggs, suggesting a new Method of hatching Salmon and Trout."

Dr. S. P. Bartlett, Field Superintendent U. S. Fisheries Station, Quincy, Ill.: "Rescue Work—The Saving of Fishes from Overflowed Lands."

Dr. T. H. Bean, State Fish Culturist of New York, Albany, N. Y.: "Notes on the Black Basses, with Special Reference to their Cultivation in Ponds."

D. C. Booth, Superintendent U. S. Fisheries Station, Spearfish, S. D.: "Fish Cultural Possibilities of the National Preserves."

Dr. H. C. Bumpus, Director American Museum of Natural History, New York City: "The Education of the People in Fishery Matters."

Charles W. Burnham, U. S. Bureau of Fisheries, Washington, D. C.: "Notes on the Collection and Transportation of an Exhibit of Bermuda Fishes."

Professor Bashford Dean, Columbia University, New York City: "Announcement of Dr. Nishikawa's Success in causing the Pearl Oyster to secrete Perfect and Spherical Pearls."

S. W. Downing, Superintendent U. S. Fisheries Station, Put-in-Bay, Ohio: "Some of the Difficulties encountered in collecting Pike Perch Eggs."

Dr. B. W. Evermann, Chief of Division of Scientific Inquiry, U. S. Bureau of Fisheries, Washington, D. C.: "The Alaska Fisheries Service," "A Pair of Fur Seal Pups in Domestication."

A. Kelly Evans, Commissioner of Game and Fisheries, Ontario, Canada: "The Practical Enforcement of Fishery Regulations."

Professor Irving A. Field, Western Maryland College, Westminster, Md.: "The Utilization of Sea Mussels for Food."

R. E. Follett, Vice-president and General Manager New England Forest, Fish and Game Association, Boston, Mass.: "Moving Pictures with lecture on Conservation of Forest Life."

Professor S. A. Forbes, Director State Laboratory of Natural History, Urbana, Ill.: "A Program for the Investigation of a River System in the Interest of Fisheries."

Samuel F. Fullerton, St. Paul, Minn.: "The Fish Culturists' Opportunity."

Dr. Theodore Gill, Smithsonian Institution, Washington, D. C.: "The Natural History of the Weakfish."

Ferdinand Hansen, President Russian Caviar Co., New York City: "On the Introduction of the European Sturgeon."

Professor Francis H. Herrick, Western Reserve University, Cleveland, Ohio: "Protecting the Lobster."

Dr. F. M. Johnson, Boston, Mass.: "*Salvelinus fontinalis* of the Sea."

President David Starr Jordan, Stanford University, Palo Alto, Cal.: "International Regulations and what they mean."

John L. Leary, Superintendent U. S. Fisheries Station, San Marcos, Texas: "The Sunfish."

Dr. M. C. Marsh, U. S. Bureau of Fisheries, Washington, D. C.: "Thyroid Tumors in Salmonoids."

W. E. Meehan, Commissioner of Fisheries of Pennsylvania, Harrisburg, Pa.: "Observations on the Small-mouthed Black Bass during the Spawning Season of 1910," "The Work of the Department of Fisheries of Pennsylvania in the Prevention of Stream Pollution."

James Nevin, Superintendent Wisconsin Fish Commission, Madison, Wis.: "Reminiscences of Forty-one Years' Work in Fish Culture."

Professor Raymond C. Osburn, Columbia University, Assistant Director New York Aquarium: "The Effects of Exposure of the Gill Filaments of Fishes."

H. Wheeler Perce, President National Association Scientific Angling Clubs: "Some General Remarks on Fishing for Sport."

W. H. Safford, Superintendent Crawford Hatchery, Conneaut Lake, Pa.: "Observations on Frog Culture."

Wm. P. Seal, Delair, N. J.: "The Future of the American Fisheries Society."

Dr. F. B. Sumner, Director U. S. Bureau of Fisheries Laboratory, Woods Hole, Mass.: "Adaptive Changes of Color among Fishes" (illustrated).

W. T. Thompson, U. S. Fisheries Station, Leadville, Col.: "Is Irrigation a Menace to Trout Culture."

John W. Titcomb, Commissioner of Fisheries of Vermont, Lyndonville, Vt.: "On the Scientific Feeding of Fishes."

Dr. Charles H. Townsend, Director New York Aquarium, Acting Director American Museum of Natural History, New York City: "The Conservation of our Rivers and Lakes."

Professor H. B. Ward, University of Illinois, Urbana, Illinois: "Animal Parasites and Parasitic Diseases of Fresh-water Fish in the United States."

S. G. Worth, Superintendent U. S. Fisheries Station, Mammoth Springs, Ark.: "Atlantic River

Sturgeon in Economic Relation to Flies and Livestock," "Observations on the Natural Food of Small-mouthed Bass Fry at Mammoth Springs Station, Arkansas."

The following members have also indicated that they will present papers, but the titles have not been received:

Frank N. Clark, Superintendent U. S. Fisheries Station, Northville, Mich.

Professor T. L. Hankinson, Zoologist, Charleston, Ill.

R. S. Johnson, Chief of Division of Fish Culture, U. S. Bureau of Fisheries, Washington, D. C.

C. D. Joslyn, President State Board Fish Commissioners, Detroit, Mich.

Dwight Lydell, Michigan Fish Commission, Comstock Park, Mich.

Professor E. E. Prince, Dominion Commissioner of Fisheries, Ottawa, Canada.

A. Rosenberg, Kalamazoo, Mich.

A special anniversary program will be in readiness for distribution at the meeting. Members are requested to send to the chairman as soon as possible, the titles of all additional papers which should be included in the program, and to correct such errors as may be found in this announcement.

C. H. Townsend, *Chairman*,
W. E. Meehan,
Frank N. Clark,
Hugh M. Smith,
George P. Slade,
Raymond C. Osburn,
Special Anniversary Committee

SCIENTIFIC NOTES AND NEWS

Professor Joseph A. Holmes, of the U. S. Geological Survey, formerly professor of geology and natural history at the University of North Carolina and state geologist, has been appointed by President Taft director of the newly-established Bureau of Mines.

At the second Congress of Anatomists held at Brussels last month, papers were presented by Professor C. S. Minot, on "The Nomenclature and Morphology of Blood Cells"; by Professor G. S. Huntington and Professor F. W. McClure, on "The Development of the Lmphatic System"; by Professor Thomas G. Lee, on "The Implantation of the Ovum in Rodents," and by Professor G. C. Huber, on "Renal Tubules in Mammals."

Dr. William Osler, regius professor of medicine in Oxford University, England, is visiting this country.

Captain Scott and the members of the Antarctic expedition were entertained at Cape Town on August 21 at a banquet. Mr. S. S. Hough, the astronomer royal at the Cape, and Sir J. Rose-Innes proposed the principal toasts.

Mr. F. E. Matthes has been detailed by the U. S. Geological Survey this summer to make surveys for a detailed topographic map of the Mount Rainier National Park in the state of Washington. Mr. Matthes hopes, among other things, to make an accurate determination of the altitude of Mt. Rainier that will settle once and for all the dispute as to whether that peak is the highest point within the United States or not.

Professor George W. Patterson, of the electrical engineering department of the University of Michigan, Ann Arbor, Mich., is now in Europe on a year's leave of absence.

Charles W. Hill, who received his degree of doctor of philosophy at the University of Wisconsin this spring, has been made research chemist for the National Carbon Company at Cleveland, O.

Mr. Antonio Guell, research fellow in the engineering experiment station of the University of Illinois, having received the degree of electrical engineer from that institution, has entered the employ of the General Electric Company at Lynn, Mass.

Mrs. Margaret E. Gray provides $50,000 for the New York Academy of Medicine to establish the Landon Carter Gray Memorial Fund for the library in memory of her husband, who died about ten years ago.

The Scientific American states that a movement has been started having for its object a memorial to Robert Davidson, of Aberdeen, Scotland, who in 1839 exhibited over a large part of Great Britain a model electric railway,

the motor car being run at a speed of five or six miles per hour by means of electricity.

DR. CHARLES ANTHONY GOESSMANN, born in Germany in 1827, since 1869 professor of chemistry at the Massachusetts Agricultural College, known for his important contributions to agricultural chemistry, died on September 1.

FREDERICK AUGUSTUS GENTH, JR., formerly assistant professor of chemistry in the University of Pennsylvania, where his father was professor of chemistry, died at his home in Philadelphia, on September 1, at the age of fifty-five years.

JOHN TALBOT PORTER, well known for his work in chemical and steam engineering, died at Montclair, N. J., on August 21, at the age of eighty-five years.

DR. LOUIS HUBERT FARABEUF, former professor of anatomy at the Paris College of Medicine and member of the Académie de Médecine, has died, at the age of sixty-nine years.

THE death is announced of Louis Olivier, founder and editor of the *Revue Générale des Sciences.*

THE American Institute of Mining Engineers will hold a meeting in the Canal Zone, Panama, in November, 1910. A special steamship, accommodating about 150 passengers, has been engaged for the trip, and will sail with the party from New York on October 21, returning to New York about November 15.

THE thirty-eighth annual meeting of the American Public Health Association, will be held in Milwaukee, September 5–9, under the presidency of Dr. Charles O. Probst. The general topics for discussion are "The Relation of the University to Public Health Work," "Methods of Handling State Health Work," "The Inter-relation of National Organizations Working in the Interests of Health," "Section Reports for General Meeting," "The Present Organization and Work for the Protection of Health in the Four Countries Represented in the Association," "Sanitary Engineering Questions," "The Prevention of Mental Defects and Mental Diseases," "The Relation of Unnecessary Noises to Health," and "The Necessity for Terminal Disinfection and Quarantine."

THE program of the International Congress on Radiology and Electricity, to be held at Brussels on September 13–15 is summarized in *Nature.* Among the important matters to be brought forward is the question of radium standards and nomenclature. The congress will be divided into three sections. In the first section, general questions of terminology and methods of measurement in radio-activity and subjects connected with ionization will be discussed. The second section will be devoted to subjects relating to the fundamental theories of electricity, the study of radiations (including spectroscopy, the chemical effects of radiations, and allied subjects), radio-activity, atomic theory and cosmical phenomena, such as atmospheric electricity and the radio-activity of the atmosphere. The third section is biological, and will be devoted to the consideration of the effects of radiations on living organisms. This section will deal with purely biological subjects, as well as the use and application of various radiations for medical purposes. A long list of papers already promised is given in the program, as well as a list of members up to date. A special exhibit of apparatus relating to the work of members is to be held in connection with the congress, and members are invited to forward exhibits to the Physical Laboratory of the University of Brussels. A number of excursions have already been arranged to take place after the congress, and special facilities will be granted to members on the Belgian and French railways.

THE Union Government, South Africa, has contributed £500 to Captain Scott's Antarctic expedition. The mayor of Pretoria has also opened a fund, which Lord Gladstone, the governor-general, has headed with a subscription of £50.

A BUREAU of British Marine Zoology has been established under the directorship of Mr. S. Pace, late director of the Millport Marine

Biological Station. The objects of the bureau, according to the prospectus as quoted in *Nature* are twofold: (1) to compile a bibliography of all works dealing with the biology of the European seas, and (2) to establish a marine biological station of a movable character with adequate staff, but relatively simple and inexpensive equipment, to work at faunistic problems at one or two points on the coast, with no reference to any question of their possible economic importance.

Consul Thomas H. Norton, of Chemnitz, furnishes the following statistics concerning the attendance of students at German universities: The total number of matriculated students during the current semester (July) is 54,845, which includes 2,169 women, as compared with 51,700 during the summer of 1909, and 33,700 in 1900. In addition, mention should be made of the non-matriculated, who are entitled to attend lectures, etc., in the capacity of "listeners" or guests, which number 2,686 men and 1,226 women, and which bring the actual attendance up to 58,757. The following division of students, according to the class of studies pursued, shows certain tendencies now affecting the professional classes of the empire:

Class	1909	1910
Philosophy, philology, history, etc.	13,911	15,475
Medicine	9,462	10,682
Mathematics, science, etc.	7,385	7,937
Political economy, fiscal science	2,198	2,405
Dentistry	1,238	1,264
Theology:		
Catholic	1,776	1,840
Protestant	2,398	2,507
Law	11,657	11,323
Pharmacy	1,454	1,147
Unclassified	231	265
Totals	51,700	54,845

In the last two divisions alone is a retrograde movement visible. A standstill in the number of students of Protestant theology, which has existed for several years, seems now to be overcome. The rapid increase in the number of medical students (from 6,000 in 1908) causes much comment in Germany, where the profession is overcrowded. The twenty-one universities are classified as follows by attendance: Berlin, 7,902; Munich, 6,890; Leipzig, 4,592; Bonn, 4,070; Freiburg, 2,884; Halle, 2,451; Breslau, 2,432; Heidelberg, 2,413; Göttingen, 2,353; Marburg, 2,192; Tübingen, 2,061; Münster, 2,007; Strassburg, 1,964; Jena, 1,817; Kiel, 1,760; Würzburg, 1,429; Königsberg, 1,381; Giessen, 1,334; Erlangen, 1,050; Greifswald, 1,029; Rostock, 834; total, 54,845.

A cablegram has been received at the Harvard College Observatory from Kiel, stating that D'Arrest's comet was observed by M. F. Gonnissiat, director of the Algiers Observatory, on August 26.3892, 1910, G. M. T. in the following position: R. A. $16^h 48^m 25^s.3$; Dec. $-9° 42' 50''$. Visible in a large telescope.

The following courses in illustration of recent progress in various departments of physical investigation will be delivered at the Royal College of Science (Imperial College of Science and Technology), South Kensington, during the autumn: About ten lectures on "Color Vision," by Sir William De W. Abney, K.C.B., F.R.S., beginning on Tuesday, November 8; about ten lectures on "Spectroscopy," by Assistant Professor A. Fowler, F.R.S., beginning on October 10; about ten lectures on "The Internal-combustion Engine, illustrated by a Study of the Indicator Diagram," by Dr. W. Watson, F.R.S., beginning on October 13; about nine lectures on "Radio-activity and Electric Discharge," by Professor R. J. Strutt, F.R.S. The following courses, of about ten lectures each, will be given (details to be announced later): "Measurement of High Temperatures, and Optical Pyrometry," by Professor H. L. Callendar, F.R.S.; "Magnetic Properties of Metals and Alloys," by Dr. S. W. J. Smith.

From the report of the medical bureau of the Prussian department of education on the public health for 1908, as abstracted in the *Journal* of the American Medical Association, the number of births in Prussia was 1,308,283, an absolute increase of 9,902 over the previous year. Of these, 38,884 were stillborn, an increase of 229 over the previous year. The

proportion of the living born to 1,000 inhabitants was 32.99, a proportion which is smaller than that of any year previous to 1901. Of those born living, 651,426 were males, 617,973 females. The births of male children per 1,000 inhabitants diminished 0.32 over the previous year, that of female 0.15. Of all the births, 16,884 were plural, 16,716 being twins, 167 triplets and 1 quadruplet. The number of marriages in 1908 were 311,331, nearly as many in the towns as in the country. There were 693,724 deaths in 1908, an increase of 12,775 over the previous year. The excess of living births over the deaths was 575,675, which, with the exception of 1907 and 1906, is more favorable than in previous years. Of 1,000 inhabitants 19.17 male and 17.02 female, or altogether 18.03 persons died, a figure more favorable than in all previous years. The mortality in large cities of over 100,000 inhabitants remains on the average, 16.51 per 1,000 living, below the average of the entire nation (18.03). The highest mortality is shown by the city of Posen (22.24), the lowest by the city of Schöneberg (11.44). Berlin had a death-rate of 15.42.

THE Uganda Cotton Industry is the subject of a British Colonial Report by Sir H. H. Bell, which is summarized in the *Geographical Journal*. Before 1904, tentative experiments in the production of cotton had been made. In 1905–6, Uganda exported 43, and in the next year, 163 tons. Of all varieties of cotton seed, none, it was found, suited the soil and climate so well as "American upland," producing as it did a better lint, ripening earlier, opposing a stouter resistance to insect pests and blights, and yielding a quality of cotton superior to that of the original stock. In consequence, however, of the distribution of many varieties of seed and the severe competition of buyers, the cotton exported by Uganda depreciated in value from £50,000 in 1907–8 (for 858 tons, 213 unginned) to £41,000 (for 1,150 tons, 640 unginned). To prevent the ruin of an industry of so great promise, the cultivation of cotton was, with the consent and cooperation of the chiefs, subjected to stringent governmental control. Two large seed farms were established in 1908, one in Buddu, the other in Busoga. Pending the arrival of expert officers, their management was provisionally committed to overseers engaged in British East Africa, under superintendence of the officer in charge of the Botanic Department. Despite the lack of expert knowledge and the decimation by famine of the population of Busoga province in 1908, fair results are being obtained. Thanks to the chiefs' loyal assistance, it is now difficult to find a plant other than of American upland, and the evolution of a hybrid peculiarly adapted to the climatic conditions of the country is deemed probable. The stringent regulations of 1908 have been relaxed, save that the distribution of seed remains for some time longer under government control. In spite of the restrictive regulations, Uganda exported, in 1908–9, 1,150 tons of cotton, 650 unginned. Under the head of the Cotton Department and a staff of instructors, "immense improvement and extension of the industry is confidently expected."

UNIVERSITY AND EDUCATIONAL NEWS

AUGUSTANA COLLEGE, Rock Island, Ill., which celebrated its semi-centennial anniversary last June, benefits under the will of the late Hon. C. J. A. Ericson, of Boone, Ia., to the extent of $56,000, which goes to the general endowment fund of the college.

THE council of Oxford University, at the instance of its chancellor, Lord Curzon, has recommended that Greek shall cease to be a compulsory study.

DR. ROBERT J. ALEY, superintendent of public instruction for Indiana, and for eighteen years professor of mathematics at Indiana University, has been elected president of the University of Maine and will take office December 1.

PROFESSOR JAMES B. SHAW, of James Milliken University, and Dr. Arnold Emch, of the Obere Realschule, at Basel, Switzerland, have been appointed as assistant professors of mathematics at the University of Illinois. Dr. Emch will take up the duties of his new position on February 1, 1911.

The trustees of the Massachusetts Agricultural College have established a department of zology and geology with Mr. C. E. Gordon as its head.

Dr. Bird T. Baldwin, who for the past year was a lecturer in the University of Chicago, has accepted a call to an associate professorship in education and head of the school of practise teaching in the University of Texas.

Dr. Frederick P. Gay, of the Harvard Medical school, has been appointed head of the department of pathology of the University of California. Dr. H. B. Graham, who recently returned to Berkeley from Austria, has been appointed assistant professor of hygiene.

Dr. F. L. Haley, of Hoosick Falls, N. Y., has been made professor of physiologic chemistry and bacteriology in the medical department of the University of Alabama. Other additions to the faculty are: Dr. James F. Harrison, professor of chemistry and materia medica; Dr. M. Toulmin Gaines, associate professor of pathology and histology, and Dr. William H. Oates, associate professor of therapeutics.

DISCUSSION AND CORRESPONDENCE

THE LUMINOSITY OF TERMITES

In Science of January 7, 1910, I published a note in regard to the luminosity of termites. To that communication I am now able to make the following additions. Herbert H. Smith, a thoroughly trustworthy naturalist, makes the following note at page 139 of his work on "Brazil, the Amazons, and the Coast," New York, 1879:

> There are white ant-hills along the sides—pale glows of phosphorescent light, like coals in the ashes. They look ghostly in the darkness.

In a footnote he adds:

> The phosphorescence is in the insects; and I believe that it is peculiar to one or two forest species.

The locality where Mr. Smith observed this phosphorescence is near Santarem in the valley of the Tapajos.

Bearing on the other side of the question I here give a translation of a letter just received from my friend Dr. Joaquim Lustosa, a Brazilian mining engineer living at Lafayette, state of Minas Geraes, of whom I have made inquiries about this matter. Dr. Lustosa writes as follows under date of July 8, 1910:

> I have just received authentic information to the effect that in the state of Matto Grosso, in the low swampy lands along streams, and especially in the rainy months beginning with October myriads of fireflies are seen covering the ground. My informant, who has lately come from the upper part of Matto Grosso where it joins Bolivia, tells me that he has seen at night many of the nests of white ants that have been abandoned by the ants themselves entirely covered by fireflies that come from the small openings over the whole surface of the anthill. Is it possible that the fireflies select these abandoned anthills as places in which to rear their larvæ? . . . Unfortunately, I have never observed anything of the kind hereabout, though I have been interested in the subject in order to furnish you information.

It should be noted that the case mentioned by Dr. João Severiano da Fonseca and referred to in my communication of December 13, 1909, was seen in Matto Grosso in the region mentioned by Dr. Lustosa.

J. C. Branner

Stanford University, Cal.,
August 9, 1910

HONEY ANTS IN UTAH

In the autumn of 1908, Mr. Guy Hart, a student in the Salt Lake High School, brought to me for identification some of the repletes of the honey ant. He had collected them at Garfield, Utah, a smelter town at the southern end of Great Salt Lake. They had been found while excavating for a house, and Mr. Hart said that they had been noticed on several occasions during the progress of excavations.

I sent a few of these repletes to Professor W. M. Wheeler, and he determined them as a variety of *Myrmecocystus mexicanus*. This variety is closely related to *horti-deorum*, but the repletes are somewhat smaller than those of that variety.

Garfield is at an elevation of about 4,243 feet. Its latitude is approximately 40° 42′ N. Honey ants have not heretofore been reported

as occurring farther north than Denver, Colo. (lat. 39° 40′ 36″ N.); nor do I know of any previous record of their having been found in Utah.

A. O. GARRETT

SALT LAKE HIGH SCHOOL

THE GOVERNMENT OF AMERICAN UNIVERSITIES

THE articles under the above caption by Professors Jastrow and Creighton in recent issues of this journal are timely contributions to one of the most important problems now engaging the attention of American educators. That interest in it is widespread, I am assured by personal conversation with representatives of college faculties from all sections of the union east of the Mississippi River.

About two years ago, local conditions forced the faculty of the Randolph-Macon Woman's College to adopt some means of conserving the scholarly status of the institution and of safeguarding the instructor's pedagogic liberty. A committee, appointed for the purpose, drafted a constitution for the college, which, after undergoing certain modifications suggested in conference with the president and board of trustees, was adopted by the board at its session in June of the current year. Its essential features are the following items, of which I would call particular attention to the fifth, sixth and seventh:

1. The fields of instruction which are at present recognized as distinct shall be constituted departments.
2. The senior professor in each field shall be head of the department, given its entire control, and held responsible for results.
3. The following grades shall be established in the instructional staff: (*a*) professor and head of department, (*b*) associate professor, (*c*) adjunct professor, (*d*) instructor, (*e*) assistant.
4. The president shall nominate heads of departments.
5. The heads of departments shall nominate their subordinates.
6. All questions affecting the educational policy of the institution shall be presented to the executive committee upon resolution of the faculty.
7. Only heads of departments may vote on questions affecting the educational policy of the college.
8. All members of the faculty except instructors and assistants may vote on questions of routine business.

FERNANDO W. MARTIN

RANDOLPH-MACON WOMAN'S COLLEGE

SCIENTIFIC BOOKS

Canada Department of Mines, Geological Survey Branch. Catalogue of Canadian Birds. By JOHN MACOUN, Naturalist to the Geological Survey, Canada, and JAMES M. MACOUN, Assistant Naturalist to the Geological Survey, Canada. Ottawa, Government Printing Bureau. 1909. Pp. viii + 761 + xviii.

This excellent piece of technical work is essentially a compend of known facts concerning the distribution and breeding habits of the birds of the Dominion of Canada, Newfoundland, Greenland and Alaska—of all America, in short, north of the main northern boundary of the United States. It is a second edition, largely rewritten and considerably expanded, of the well-known "Catalogue of Canadian Birds," prepared by John and James M. Macoun, father and son, and first published in three installments between 1900 and 1904. An important part of the contents of this volume is the product of field observations by the authors and by Mr. Wm. Spreadborough, made during many years of service on the Geological Survey of Canada, those of the senior author beginning in 1879, of the junior Macoun in 1885, and of Spreadborough in 1889. With their personal notes have been incorporated all pertinent data from the published work of other naturalists, and from manuscript lists and notes of more than a score of observers whose materials have been placed at the disposal of the compilers.

The plan of the work is extremely simple and unassuming. Preceded by no introductory discussion, and followed by no general summary, the catalogue begins at once with a discussion of the species, giving for each, in systematic succession, without descriptive matter, the details of its Canadian distribution, both geographical and ecological, its movements in migration, and its breeding habits, with descriptions of nests and frequently of eggs. The precise authority for observations reported is carefully given. Seven hundred and sixty-eight species are

discussed, representing two hundred and eighty-eight genera and fifty-five families.

Students of Canadian birds are fortunate in the possession of this cyclopedia of comprehensive and accurate information. It is scarcely less interesting and valuable to the ornithologists of the United States, who will find in it a larger mass and greater detail of reliable matter concerning many of our species than is to be found in any other like publication. It is a methodical, careful record of data of observation, simply and clearly written, for the compilation of which the authors deserve the gratitude of all students of American ornithology.

STEPHEN A. FORBES

Weitere experimentelle Untersuchungen über Artveränderung, speziel über das Wesen quantitativer Artuntershiede bei Daphniden. By R. WOLTERECK, Vehr. der Deutschen Zool. Gesellsch. 1909. Pp. 110–172, 18 text figures.

Dr. Woltereck has selected the very variable *longispina* group of *Daphnias* for his studies in variation and heredity and the results on which the paper is based were obtained in experiments covering a period of three years. The plan of the investigation embraces a study of four problems: (1) The cause, extent and character of the variations in this group of crustaceans; (2) the characters possessed by hybrids resulting from the crossing of two elementary species; (3) whether a pure culture biotype can be changed through the selection of extreme variants; (4) whether and how much a long-continued exposure to a particular environmental condition will change the characteristics of a biotype hereditarily.

So far the experiments have been confined mainly to the first problem and attention has been directed chiefly to two characters, the length of the helmet and sexuality. The author found that the length of the helmet is dependent primarily on the quantity of food (an external factor) and the number of the generation (an internal factor). Indirectly also it is affected by the temperature of the water through its influence on assimilation and body activities. The length is directly proportional to food assimilation and is not affected directly by other external factors such as salt or gas content of the water, light or temperature. With respect to the internal factor, the first generations produced by ephippial eggs have small helmets but, under the same food conditions, later generations will have larger helmets. This seems to show the presence of a "Helmhöhepotenz" which has become hereditarily fixed so that the size of the helmet may be modified by food conditions, but it can not be entirely controlled by this factor. No mutations were observed.

Concerning sexuality, it was found that the sexual stage might be postponed for several generations (ten to twelve) but it was not possible to postpone this stage indefinitely in all individuals. In some cases it became obligatory in all individuals, while in other instances it became only partial and facultative. The parthenogenetic stage was found to be obligatory in all generations.

Dr. Woltereck also studied two regressive characters, the pigment fleck (Nebenauge) and the dorsal shell teeth. Some individuals, especially those belonging to the earlier generations, possessed a rather large pigment fleck while this character was entirely absent in individuals belonging to later generations. At first this was supposed to be a mutation but further study revealed the presence of a number of intermediate stages, thus showing a continuous variation. Environment did not seem to affect the variability of this character.

The dorsal teeth also showed a continuous variation in size, in position, and in heritability. Through selection the number of individuals possessing these teeth was raised to 50 per cent. in the third generation. This character was affected by a marked change in the temperature of the water. If a female having ripe eggs in her ovary were suddenly transferred from water having a temperature of 25° to water at 12° and kept at this temperature, the young produced by these eggs possessed dorsal teeth.

One series of experiments is concerned with

the production of new characteristics by overfeeding and the fixation of these characters. The time during which these experiments have been in progress has been divided into three periods. During the first period, which includes the time immediately following the starting of the culture, the form of the head varied very widely under the new food conditions, but it soon returned to the original form when original conditions were restored. In three to four months after the culture was started, the form of the head was more regular and there were fewer aberrant individuals. Young females returned more slowly to the original head form when changed to original environment. The third period began almost two years after the culture was started and it was found that the young no longer returned to the original helmet form when original conditions were restored. A larger helmet persisted, thus showing a tendency toward the fixation of a new helmet form.

All of these experiments are still in progress and a more extended report on the results is promised at some future date.

C. JUDAY

MADISON, WIS.

SCIENTIFIC JOURNALS AND ARTICLES

The American Journal of Science for September contains the following articles: "Use of the Grating in Interferometry," by C. Barus; "Fox Hills Sandstone and Lance Formation ('Ceratops Beds') in South Dakota, North Dakota and Eastern Wyoming," by T. W. Stanton; "New Occurrence of Hydrogiobertite," by R. C. Wells; "New Occurrence of Plumbojarosite," by W. F. Hillebrand and F. E. Wright; "Heat of Formation of the Oxides of Cobalt and Nickel," and sixth paper on the "Heat of Combination of Acidic Oxides with Sodium Oxide," by W. G. Mixter; "Mosesite, a New Mercury Mineral from Terlingua, Texas," by F. A. Canfield, W. F. Hillebrand and W. T. Schaller; "Researches upon the Complexity of Tellurium," by W. R. Flint; "Gravimetric Estimation of Vanadium as Silver Vanadate," by P. E. Browning and H. E. Palmer; "Brachiopod Genus *Syringothyris* in the Devonian of Missouri," by C. Schuchert; "George Frederic Barker."

SPECIAL ARTICLES

THE INFLUENCE OF EXTERNAL CONDITIONS UPON THE LIFE CYCLE OF HYDATINA SENTA

THE search for the factors which regulate the production of the parthenogenetic and the sexual phases in the life history of the rotifer, *Hydatina senta*, has been conducted for some time. Maupas concluded that temperature regulated these two phases, while Nussbaum found that the controlling factor was food. Punnett and the writer[1] were unable to confirm these results. Recently Shull[2] has claimed that the absence of certain chemicals in the culture water causes the sexual phase to be produced, while the presence of these chemicals prevents the appearance of the sexual phase. This suggestion is probably partially true, but it does not seem to express the whole truth, nor solve satisfactorily the whole problem.

During the past two years I have kept pedigree strains or families of these rotifers continually in the laboratory and have made some observations which may lead to a clearer understanding of the conditions which control the production of the sexual and parthenogenetic phases in the life cycle of this rotifer.

A general food culture for rotifers is usually made by adding about one hundred and fifty grams of fresh horse manure to about two thousand cubic centimeters of ordinary water and allowing this mixture to stand at room temperature after being inoculated with a miscellaneous lot of microorganisms. It is readily noticeable that in large jars of such newly made food cultures in which rotifers have been placed, that sexual females (females capable of producing either males from small parthenogenetic eggs or females from large fertilized eggs) appear quite abundantly for a few days or weeks, then gradually disappear and only parthenogenetic females remain in the cultures as they become older.

In June, 1909, several general cultures

[1] *Journ. Exp. Zool.*, Vol. 5, pp. 1–25.

[2] *Amer. Nat.*, Vol. 44, pp. 146–150.

of rotifers in jars which had been standing in the laboratory from four to twelve weeks were examined. Lots of five to eight hundred individuals were selected at random from each of these jars. In some of these lots three to five males were found, while in lots from other jars no males at all were found. In jars of new food cultures five to ten days old and stocked with individuals from these old culture jars, sexual females constituted as high as thirty per cent. of the individuals present.

In some experiments made this summer in which a few parthenogenetic females were placed in vials containing a small green flagellate, *Chlamydomonas,* and put into direct sunlight in order that the flagellates might remain active and serve as food for the rotifers, and also to aerate the culture water in the vials, males appeared either on the third or fourth day and on the immediately following few days. Then the males disappeared entirely and the parthenogenetic females increased in numbers to fifteen hundred to two thousand in each vial in the course of a week and a half to two weeks. These experiments were repeated several times with always the same result—that as the culture water became older the sexual females disappeared and the parthenogenetic females increased in numbers.

However, in the summer of 1909 in a pedigree strain of rotifers supplied entirely with water and food from an old culture jar, a line of parthenogenetic females was produced for twenty-six generations, but as the old culture water became low in the jar and the liquid very near the bottom was used, males appeared. This food culture was about eleven or twelve weeks old at this time and had been producing only parthenogenetic females for seven to eight weeks, and then under apparently the same conditions, suddenly produced sexual females.

This failure of an old culture water to produce continuously parthenogenetic females, and the high percentage of sexual females found in new culture water, suggested the possibility that the production of sexual females might be due to the *presence* of definite chemical substances in the culture water. The possibility of this suggestion was strengthened by several cases of male epidemics which have occurred in my cultures.

In new horse-manure cultures at a temperature of 18–22° C., sexual females occur sometimes as high as thirty per cent., as has already been stated. In May, 1909, a large culture about two to three weeks old, containing rotifers, was standing in a south exposed window where it received the direct sunlight for a few hours each day and had its temperature thus raised to 28–30° C. Several lots of large eggs were selected at random from this culture during a period of three to four days, and placed at room temperature in some of the culture water in which the eggs were laid. In some of these lots of thirty to forty eggs, ninety-three per cent. developed into sexual females. Soon the parthenogenetic females began to increase and the sexual females to decrease in numbers, so that about a week later only about five per cent. of the individuals in the jar were sexual females. In another jar of newly made culture, in June, 1909, which was under the same conditions as the former jar, practically the same results were obtained again.

In November, 1909, the laboratory was closed one Sunday and the steam heat left on. The temperature rose to 26° C. or more. In three pedigree strains of rotifers which happened to be subjected to this great change of temperature, sexual females appeared in each strain in the following generations in greater numbers than they had appeared since the preceding May and June. It may be recalled that Maupas obtained a very high percentage of sexual daughter females when he subjected the adult mothers to a temperature of 26–28° C. Of course, when these females were at the high temperature the culture liquid in which the females were living was at the same temperature.

From a consideration of these general observations, it is conceivable that in newly made cultures of horse manure and water during the great chemical changes that are taking place in the decomposition that occurs during the first two weeks, definite but transitory chemical compounds are formed which so act

upon the parthenogenetic female as to cause her to produce sexual daughter females. These chemical compounds may not be final products of decomposition, but break up into or form other products which possess different properties. When these compounds are forming, a higher temperature under certain conditions augments them and consequently they appear in greater abundance suddenly, and thus act upon the parthenogenetic females and cause male epidemics in the third generation.

As the culture water becomes older the decomposition rapidly decreases and the special chemical compound which causes sexual females appears in inappreciable quantities, if at all, throughout the liquid. However, in the bottom of old culture jars decomposition may not have ceased, as was evident in the breaking up of the parthenogenetic pedigree strain into sexual females at the end of twenty-six generations. This chemical substance is evidently something which appears more or less abundantly at first in decomposition and then later disappears or its influence is counteracted by other substances.

Whether the production of parthenogenetic females is sometimes brought about by the action of a different chemical compound or sometimes by the mere absence of the sexual female producing chemical compound is not as yet altogether clear, but the latter possibility seems more probable.

On January 16, 1910, I began feeding two pedigree strains of rotifers with the small flagellates, *Polytoma,* which grew in a culture of about one hundred grams of fresh horse manure and five hundred cubic centimeters of tap water, that had been steam sterilized for about one hour. The *Polytoma* grew very quickly in these cultures and in 24–48 hours immense numbers of them were produced. These new food cultures of *Polytoma* ranging from 24–96 hours old were diluted, one part culture water to two parts tap water, and used to grow the rotifers in. Such diluted *Polytoma* cultures, none of which were over 96 hours old and in which the culture water was cooked, have been used from January 16 to August 13. In each generation of these two strains ten daughter females were isolated from one to three mothers. Each individual was placed in a separate watch glass and kept at room temperature. In these two strains of a hundred generations and consisting of one thousand individuals in each strain no sexual females have ever appeared during a period of about seven months.

These long parallel series of parthenogenetic females are similar to Punnett's pure female strains. However, the parthenogenetic females of both strains in the generations between the ninetieth and the one hundredth, have produced sexual daughter females when placed in very little dilute culture solution and fed upon the green flagellate, *Chlamydomonas,* thus showing that these are not pure parthenogenetic female strains, and that the production of sexual females has been suppressed since January by some condition of the culture water.

These results are similar to those obtained by Shull who used old culture water, although produced by using newly made cooked culture water and extending over a longer period of time. At the end of some starvation experiments in which Shull used dilute culture water, he makes this general concluding statement, "The larger proportion of sexual forms in the starved families is not due to lack of food, but to the absence of chemicals which, in the well-fed families, prevent the appearance of the sexual forms."

In February, 1910, I had in the laboratory some pure cultures of a colorless flagellate, which seemed to be a species of *Peranema.* These flagellates were very resistant and could live and swim about normally several hours in distilled water, and were readily eaten by the rotifers. These flagellates were taken in quantities, put into large test-tubes, placed on a large electric centrifuging machine, and collected in the bottom of the tubes by centrifugal force. The old culture water was removed, clean tap water added, and the contents thoroughly mixed. Then it was centrifuged again and the protozoa collected at the end of the tubes. This process was repeated

four or five times until the protozoa were thoroughly washed, and no trace of the old culture water remained.

Several parthenogenetic female rotifers were also washed by dropping them into four or five successive dishes of tap water. Then series of watch glasses were prepared containing five cubic centimeters of distilled water in which there were large numbers of the Peranema, and amounts of cold culture water varying from one drop to four cubic centimeters. In pure distilled water the rotifers soon died and also in the dishes containing very small quantities of the old culture water, while in the dishes containing larger amounts of the old culture water the rotifers lived and reproduced normally. Under these varying conditions three generations were reared, but no sexual females were produced in any of the dishes.

These experiments in which the quantity of old culture water varied from zero to four cubic centimeters and only parthenogenetic females were produced seem to indicate that the substance which causes sexual females to be produced was absent altogether in this old culture water. If this is true, then perhaps the mere absence of the substance which causes the sexual females to be produced is always sufficient to cause the production of parthenogenetic females and it is unnecessary to look for a specific substance which causes their production.

Newly made uncooked cultures of horse manure and water in which rotifers can live readily are more or less dilute, but as they grow older they become more concentrated by the end products of decomposition. If mere dilution of substances in the culture water, as Shull seems to maintain, produces sexual females, then epidemics of males ought to occur in culture water during the very first days when such culture water is most dilute, and not several days later as it becomes more concentrated by the end products of decomposition. However, the epidemics of males that occurred in my two general culture jars which were between two and three weeks old were preceded by a production of males which did not exceed thirty per cent. during a period of at least a week.

In some pedigree families of rotifers that I observed in 1907 and 1908, it was found that in any single family of forty to fifty daughters, if there were any sexual daughters they occurred among the first half of the family. When a mother was isolated she was fed and then remained in the same food culture water without the least change until all of her daughters were produced. Sometimes she would produce ten or more sexual daughters in succession, which were often preceded by several parthenogenetic sisters and always followed by parthenogenetic sisters.

It is plain that dilution of the culture water did not occur to cause these series of sexual daughters and it is conceiveable that the chemical substance that produces males, in some cases, when sexual females occurred among the first daughters, was present in the culture water at the time of isolation of the mother, and in other cases, when the sexual females appeared between the tenth and twenty-fifth daughter, this substance was formed some time after the mother was isolated and had laid some of her eggs. In all cases its influence disappeared as the culture became older and no sexual daughters appeared in the last half of the family.

It seems evident from all the observations that some culture waters totally lack the power to cause sexual females to be produced, others lack this power at first, but acquire it later, while still others possess it as the cooked new cultures and some old cultures, but are unable to use it unless the culture water is diluted.

In a summary I would maintain that there seems to be a definite, but transitory, chemical substance produced in appreciable quantities in the decomposition processes in newly made horse manure cultures that can so act upon the parthenogenetic females as to cause them to produce sexual daughter females. When this substance is absent no sexual females are ever produced, but only parthenogenetic females are produced, and when this substance is present in culture water which is too concentrated its influence is counteracted and no

effect is produced on the parthenogenetic females.

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A REPORT ON THE FRESH-WATER PROTOZOA OF TAHITI[1]

THE following brief report is a result of some work done upon the protozoa of Tahiti during the months of July and August, 1908.

An oceanic island is always an interesting field for the investigation of the higher forms of animals, because of its faunal peculiarities or deficiencies, but a valid question arises, namely, may we expect these same peculiarities or deficiencies to exist with respect to animals of the lowest rank?

So far as the writer has been able to determine, no list of fresh-water protozoa of a mid-ocean island has previously been reported.

Tahiti, the largest of the Society group, is situated 17½° south latitude, 149½° west longitude. It is a high island of over 400 square miles, of volcanic origin, more or less densely covered with a tropical vegetation. Mountains of the interior reach a height of nearly 8,000 feet, and numerous streams of fresh water flow down the valleys across the narrow plain to the sea.

During the winter months of July and August, in Tahiti, the small streams are in a low condition, it being the dry season, and many of them are choked with plants of low orders, which would apparently be a fit condition for the presence of a rich microscopic fauna.

During the brief time allotted to the study of the protozoa, collections were made in many places from the waters of this border zone a few yards from the sea and from its level to a few feet above.

In all, forty-four species were observed and studied with considerable care. Of these, thirty-six were positively identified, and eight referred to their proper genera, but the species undetermined.

[1] Read before the Central Branch of the American Society of Zoologists at Iowa City, April, 1910.

Of the thirty-six species identified, nine were of the class Sarcodina, six of the class Mastigophora, and twenty-one of the class Infusoria. Of the undetermined species, two were rhizopods and six ciliates.

All of the thirty-six species studied in Tahiti are more or less common in the waters of this state; twenty of them have been reported from Boulder, Col., by Cockerell; and nearly all of them from Connecticut by Conn.

Penard, in the *American Naturalist* for December, 1891, lists thirty-six species of rhizopods found in the Rocky Mountains near Caribou, Col., at a height of 10,000 feet, and thirteen species at 12,000 feet. Of the thirty-six species listed by Penard at an elevation of 10,000 feet, six species were found in tropical Tahiti within a few feet of the level of the sea. Of the thirteen species listed by Penard found at an elevation of 12,000 feet, one *Difflugia pyriformis,* is a rather common rhizopod in Tahiti at sea-level.

Penard calls attention to the fact that the rhizopoda of higher altitudes are those with lobe-like pseudopodia, the forms with ray-like pseudopodia being absent. It may be added that the predominating rhizopods of the sea-level are also of the lobose type, and a majority are protected by shells. Only one species of rhizopoda with ray-like pseudopodia was found in Tahiti.

Taking as a basis the list of protozoa reported by Stokes in 1888, the list reported by Conn in 1905, and the list of the writer in 1906, it is quite safe to say that the relative proportion of the protozoa for the United States of the three classes (sporozoa not included), is approximately as follows: Sarcodina, 15 per cent.; Mastigophora, 25 per cent., and Infusoria, 60 per cent.

Taking forty-four species of Tahiti as a basis, the proportion is as follows: Sarcodina, 25 per cent.; Mastigophora, 14 per cent.; Infusoria, 61 per cent.

It would seem from these observations that the proportion of infusoria reported in the oceanic island holds true to that of the United States, a variance appearing in the case of the other groups.

Among the pseudopodia-bearing forms, *Ar-*

cella vulgaris and *Centropyxis aculeata*, shell-bearing rhizopods, were most abundant. These are among the more common species in the United States. Only one species with ray-like pseudopodia was observed, a member of the genus *Raphydiophrys*, probably a new form.

The scarcity of Mastigophora was especially marked. In material where certain common forms are usually found in swarms there were none. The Euglenidæ were few in species and in number of individuals. Only one form of flagellate was at all common, *Chilomonas paramecium*, which may be found almost everywhere in stagnant water.

The class Infusoria was well represented except in a few particular groups.

The Vorticellidæ, common forms with us, were represented in the collections by only four species, rarely seen and only one of which could be identified as a North American species. None of the beautiful colonial examples of *Epistylis* or *Carchesium* were found.

Stentor was not discovered, even in the old infusions, after fermentation had taken place.

No members of the subclass Suctoria were obtained. This failure, however, does not indicate that none existed, as these forms are by no means abundant in any locality.

The list as reported is not a large one, but nevertheless is a representative one, comprising 21 families and 34 genera.

In June, 1908, the writer did enough work on the protozoa of southern California to conclude that the one-celled animals of that region are identical with those of the central portion of the United States, and the species here are, for the most part, reported from eastern United States by Stokes, Conn, Palmer and others.

A species of *Colpoda*, common in this state, was, during the summer of 1906, the predominating species in infusions of the leaves of the shrub on Loggerhead Key, Dry Tortugas.

It is well known that environment may have a direct morphological and physiological influence upon the protoplasm of the unicellular animal, and, no doubt, external factors are instrumental in the production of the numerous variations of certain protozoa, yet the significant fact is that there is a constancy of species and that a given species may flourish under very diverse habitat conditions.

All of the evidence indicates that very many species of protozoa are widely distributed throughout the United States and many of these same species are common forms in oceanic islands separated from our shores by several thousands of miles of sea.

It is safe to conclude, I believe, that on every land surface of the earth, where moisture abounds, within wide range of latitude and altitude, we may expect to find, not only genera, but species of protozoa identical with those of this immediate vicinity.

Appended is a list of the species of protozoa reported from Tahiti.

Sarcodina:

- *Amœba proteus*
- *Amœba radiosa*
- *Dinamœba* sp.
- *Difflugia pyriformis*
- *Arcella vulgaris*
- *Arcella discoides*
- *Centropyxis aculeata*
- *Cochliopodium bilimbosum*
- *Euglypha alveolata*
- *Trinema enchelys*
- *Raphidiophrys* sp.

Mastigophora:

- *Euglena viridis*
- *Euglena acus*
- *Astasia trichophora*
- *Entosiphon sulcatus*
- *Notosolenus opocamptus*
- *Chilomonas paramecium*

Infusoria:

- *Coleps hirtus*
- *Prorodon edentatus*
- *Mesodinium* sp.
- *Lacrymaria truncata*
- *Lionotus fasciola*
- *Loxodes rostrum*
- *Chilodon cucullulus*
- *Loxocephalus granulosum*
- *Urocentrum tubro*
- *Microthorax sulcatus*
- *Cinetochilum margaritaceum*
- *Paramecium caudatum*
- *Paramecium trichium*

Cyclidium glaucoma
Metopus sigmoides
Uroleptus agilis
Oxytricha fallax
Stylonychia sp.
Stylonychia sp.
Euplotes patella
Euplotes charon
Aspidisca costata
Vorticella citrina
Vorticella sp.
Vorticella sp.
Vorticella sp.

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THE FOOD REQUIREMENTS OF GROWING CHILDREN

A COMPARATIVELY large number of investigations have been made with the view of determining the amounts of nutrients required in average normal adult life and, although they can not be considered as final, some rather definite conclusions have been drawn. The data available for children are much more limited. It is recognized that a higher allowance should be given them to provide for their greater degree of tissue building, greater loss through radiation and evaporation from the relatively larger body surface, and, possibly, for their comparatively greater activity. Certain standards have been proposed for children, sometimes from limited observations, sometimes from theoretical considerations. Thus the following percentages of adult requirements have been suggested[2] for children.

Age, Years	Foley	Atwater	U.S. Bureau of Labor	Rowntree	Engel
7 to 10	—	50 to 60	75	50	57
11 to 14	60	70 to 80	90	60	70

The U. S. Department of Agriculture[3] has adopted standards for the nutrients for children at different ages, assuming, among others, as the proper food for a child of from 6 to 9 years 50 per cent. of the food of a man, that is, 53 grams of protein and 1,750 calories of energy, and for a boy of 12 years 70 per cent. of the food of a man, which would be 74 grams of protein and 2,450 calories of energy.

Knight, Pratt and Langworthy[4] have recently issued the results of dietary studies in children's homes in Philadelphia and Baltimore and have there reviewed the literature. In Philadelphia, 80 children whose ages were from less than 6 up to 18 years, averaging about 10 years, consumed per day an average of 67.6 grams of protein, 57.9 grams of fats and 270.1 grams of carbohydrates with a total energy value of 1,867 calories. The duration of the test was seven days. In Baltimore, 115 boys and girls aged from 4 to 17 years, with an average age of 12 years and weighing from 31 to 109.5 pounds, consumed an average of 65 grams of protein, and other food to a total of 1,798 calories of energy. In another home in Baltimore for colored children 25 boys, from 3 to 13 years of age, and weighing from 37 to 85 pounds each, consumed daily 50 grams of protein and the fuel value of the food was 1,677 calories. The average of the ages was 9 years. In each of the Baltimore tests the duration was 21 meals. In one the children had an abnormally low body weight and in the other they were "none too well nourished."

It is evident, in tests like these last, where there is so great a variation in age and body weight that definiteness is wanting in the results, and that they can stand for nothing more than very general averages. Considering that there is no general agreement as to adult requirements, standards stated as fractions of the amounts necessary for adults are obviously not exact. The value of more definite information as to children's needs is evident.

The daily dietaries of two boys were deter-

[1] From the Chemical Laboratory of the University of Iowa.

[2] Quoted by Chapin, "The Standard of Living among Workingmen's Families," Charities Publication Committee, New York, p. 15.

[3] U. S. Department of Agriculture Yearbook, 1907, p. 365.

[4] Bulletin 223, Office of Experiment Stations, Washington. See also Experiment Station Bulletins 21 and 45 for literature.

mined by weighing at the table all food eaten, except water, for 29 days in November and December. The first (P) was 12 years and six months of age and approaching puberty. His weight without clothing was 50.5 kilograms and his height 5 feet. The second (A) was 8 years and 6 months old, weighed without clothing 27.4 kilograms and measured 4 feet, 5 inches in height. The health of both was good before, during and has been since the test. The composition of the food was calculated,[5] either directly or from the materials known to have been used in its preparation. The quantities eaten did not differ from those usually taken by these children. The quality was plain but wholesome—for breakfast, a cup of cocoa made with much milk, buttered toast, fruit and occasionally a piece of cheese; at noon, meat or fish with bread, butter and potatoes, an additional vegetable, often pudding and a glass of milk; for supper, ordinarily no meat, bread and butter, with an egg or cheese, fruit and milk. The results follow:

	Protein, Grms. per Day	Fats, Grms. per Day	Carbohydrates, Grms. per Day	Protein per Kilo. of Body Weight per Day	Calories per Day	Calories per Kilogram of Body Weight
P	87.8	114.9	381.2	1.74	2992	59.2
A	63.0	78.3	259.8	2.30	2051	75.0

Naturally the food contained relatively much more energy than that regarded as necessary for adults; 35 calories per kilogram of body weight (Chittenden[6]); 44 calories per kilogram (Voit[7]); or 35–38 calories per kilogram for actual body maintenance (Maurel[8]). Comparison with the standards for children can be made on the basis of age or on that of body weight. On the basis of age the amounts of protein and of total energy used here are higher than those of the most common standards. Comparing on the basis of body weight, the energy value of the food consumed by these children was also greater than that of most standards, differing least from that of the United States Bureau of Labor. It will be noted that the weights of both children are greater than those commonly assumed for such ages.[9]

Maurel allows 1.75 grams of protein per kilogram of body weight below the age of sixteen for maintenance and growth of the organism, without providing for muscular work. Reckoned in this way there should have been 88.4 grams of protein for P and 48 grams for A. This corresponds to the amount used by P but is much less than was used by A. As far as conclusions can be drawn from two cases it would seem that Maurel's standard is not sufficiently elastic to use for all ages of childhood.

In order to be of the greatest value a standard should be independent of variable or uncertain factors. Hence there is an objection to basing one for children's food upon a percentage of an adult standard which may vary from that of Chittenden (*l. c.*) of less than 2,000 calories per day to that of the United States Department of Agriculture (*l. c.*) of 3,500 calories.

The methods employed in this investigation are perhaps open to the usual criticisms; that the amounts eaten are not necessarily those required for keeping the organism in its best condition and that neither the food nor the excreta were analyzed to determine exactly the income and outgo. As opposed to these we may consider that the food eaten was the same in kind and amount as that ordinarily consumed, that at all times the diet has been carefully supervised, a plain and wholesome food being provided and over-eating being habitually discouraged, and that the appetite must, therefore, be regarded as normal and some indication of the needs of the body.

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[5] "The Chemical Composition of American Food Materials," Atwater and Bryant, Washington, 1906.

[6] "The Nutrition of Man," New York, 1907, p. 177.

[7] "Physiologie des allgemeinen Stoffwechsels und der Ernährung," p. 520.

[8] *Rev. Soc. Sci. Hyg. Aliment.*, 3, 1906, p. 763.

[9] Metropolitan Life Insurance Company Tables. Bowditch, "Diseases of Infancy and Childhood."